Teaching and Educational Methods

Creating and Implementing Undergraduate Research Experiences: An Example for Analyzing the Size, Structure, and Performance of U.S. Food Manufacturing Industries

Yuliya V. Bolotova[a], Luke Juffer[a], Haylie Moore[a]
[a]*Iowa State University*

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Abstract
The article explains how to create and implement undergraduate research experiences using an example for analyzing the size, structure, and performance of U.S. food manufacturing industries. The research projects discussed in the article utilize publicly available data reported by the U.S. Census Bureau. The food manufacturing industries can be analyzed at the U.S., regional, and state level. In addition to gaining valuable data collection and analytical research skills, students acquire knowledge on economic and business aspects of food manufacturing industries that can be useful in their future careers. The research example presented in the article can be easily modified to fit the course, the level of undergraduate students, and the audiences.

1 Introduction

This article provides an example of how to create and implement a research experience for undergraduate students. This example demonstrates that an instructor can provide a clearly defined research topic area, guidance on how to access publicly available secondary data, and instruction on specific methods for analyzing these data that are well within the skill sets and academic development of a typical undergraduate student.

The research example is an analysis of the size, structure, and performance of food manufacturing industries in the United States. The research projects developed using this example would utilize publicly available data reported by the U.S. Census Bureau (U.S. Census Bureau 2024a). The food manufacturing industries can be analyzed at the U.S., regional, or state level. In addition to gaining valuable data collection and analytical research skills, students acquire knowledge on economic and business aspects of food manufacturing industries that can be useful in their future careers.

The student learning objectives are:

1. Locate economic data in the U.S. Census Bureau publicly available databases and use these economic data to characterize the size, structure, and performance of the U.S. food manufacturing industries.

2. Assess the revenue structure, profitability, and economic effectiveness of food manufacturing industries by using revenue-related indicators (e.g., value of shipments and value added), cost-related indicators (e.g., annual payroll, cost of materials, and capital expenditures), and number-related indicators (e.g., number of companies, number of establishments, and number of production workers).

3. Conduct benchmarking analysis of state and regional industry performance.

The article is organized as follows. Section 2 discusses the place in the curriculum of the undergraduate research projects discussed in the article. Section 3 explains the classification of food manufacturing industries and data sources. Section 4 discusses economic indicators that are suitable to be used in undergraduate research. Section 5 explains alternative methodologies that can be used to analyze the size, structure, and performance of food manufacturing industries. Section 6 outlines

alternative designs for undergraduate research projects. Section 7 discusses potential audiences for students' research outputs. Section 8 is the conclusion and recommendations. The teaching note Excel file includes yearly data for the U.S. food manufacturing industries for the period of 2018 to 2021 reported in the U.S. Census Bureau Annual Surveys of Manufactures that can be used in undergraduate research projects.

2 Place in the Curriculum

The research projects developed using the example presented in this article can be incorporated in a variety of undergraduate courses in several ways. First, these research projects can be used in stand-alone undergraduate research courses as explained in this section. Second, these research projects can be incorporated in capstone courses, for example in an "Agribusiness Management" course typically offered as a capstone course in undergraduate agribusiness programs. Third, these research projects can be assigned in senior-level courses where research projects are required. The course examples include "Analysis of Food Markets," "Agribusiness Management and/or Strategy," "Agricultural and Food Marketing," "Food System Organization and Policy," "Regional Economics and Policy," and "Agricultural and Food Policy."

The research projects discussed in the article were offered to first-year undergraduate Honors Program students, who took HON 290H "Undergraduate Honors Students Research" course taught at Iowa State University and administered by the Honors Program. During the fall semester, instructors teaching this course upload descriptions of their research projects to be available to first-year Honors Program students on the Honors Program webpage. In addition to the research project descriptions, instructors specify skills that students selecting the projects should possess and their responsibilities. The description of the research project discussed in this article is included Appendix I. During the fall semester, first-year Honors Program students select research projects that they are interested in working on during the following spring semester.

Two first-year undergraduate Honors Program students were enrolled in this course in Spring 2023. One student is an Economics major student. This student conducted a comparative analysis of the size, structure, and economic effectiveness of food manufacturing industries in three states with a similar agriculture and food manufacturing profile located in the U.S. Midwest region (Iowa, Illinois, and Missouri). The other student is a Global Resource Systems major student. This student evaluated the revenue structure and profitability of food manufacturing industries located in Iowa.

The class met in-person approximately two times a month during Spring 2023. Canvas was used to upload class materials: literature, web-links to data sources, sample data sets, etc. During the first three to four meetings, the instructor explained the main economic indicators, data sources and data collection procedure, and alternative methodologies that could be used to analyze these data. Each student made an individual decision on the methodology to use and geographic scope of their analysis. The Honors Program at Iowa State University requires students registered for this course to present their research during either the Spring Undergraduate Honors Research Symposium or in small discussion groups. By the end of March, both students completed data analysis in Excel and prepared PowerPoint presentations.

3 Food Manufacturing Industries

To classify all industries, the U.S. Census Bureau uses the North American Industry Classification System (NAICS), which was adopted in the United States, Canada, and Mexico in 1997 (U.S. Census Bureau 2024a). NAICS replaced the Standard Industrial Classification (SIC) system that had been used in the United States prior to 1997. According to NAICS, the food manufacturing industry group (311)[1] includes

[1] The NAICS code is in the parentheses.

nine groups of individual industries: animal food manufacturing (3111), grain and oilseed milling (3112), sugar and confectionary product manufacturing (3113), fruit and vegetable preserving and specialty food manufacturing (3114), dairy product manufacturing (3115), animal slaughtering and processing (3116), seafood product preparation and packaging (3117), bakeries and tortilla manufacturing (3118), and other food manufacturing (3119).

This classification is referred to as a four-digit classification level. Each of these groups of industries includes a number of sub-groups or product classes, up to a six-digit classification level. For example, dairy product manufacturing includes dairy product (except frozen) manufacturing (31151) and ice cream and frozen dessert manufacturing (31152). Dairy product (except frozen) manufacturing (31151) includes fluid milk manufacturing (311511) and cheese manufacturing (311513), among other product classes.

The following two U.S. Census Bureau surveys are the main sources of data (economic indicators) that can be used to analyze the size, structure, and performance of food manufacturing industries in the United States. The first one is the U.S. Economic Census surveys that are conducted every five years (U.S. Economic Census 2024). The second one is the Annual Survey of Manufactures (U.S. Census Bureau 2024b). Most of the economic indicators that can be used to analyze the size, structure, and performance of food manufacturing industries in undergraduate research are available in both surveys. The data reported by the U.S. Economic Census and Annual Survey of Manufactures are widely used by various government agencies, individual business entities, and trade organizations.

The U.S. Census Bureau surveys are conducted on an establishment basis. All economic indicators are reported per establishment and then aggregated over all establishments comprising a particular product class and industry. An establishment is a single physical location at which business is conducted (i.e., plant, warehouse, or shop). It may or may not be identical with a company (i.e., firm or enterprise). A firm can have only one establishment; in this case the establishment and the firm are identical. However, in many cases, the same firm has more than one establishment. For example, many food manufacturing companies operate more than one plant often located in different geographic areas. Each establishment is included in a separate industry classification conditional on its main activity, which may be different from its company's main activity.

4 Economic Indicators

The main economic indicators that can be used to analyze the size, structure, and performance of food manufacturing industries in undergraduate research can be generally combined into three categories. ***The number-related indicators*** include number of companies, number of establishments, number of employees, number of production workers, number of production workers hours, etc. ***The cost-related indicators*** include annual payroll, cost of materials, capital expenditures, etc. ***The revenue-related indicators*** include the value of shipments, value added, etc.

The economic indicators are reported for each industry (at all available digit-classification levels) for a particular calendar year. In the case of the Annual Survey of Manufactures, economic indicators that can be used in undergraduate research are reported for each calendar year (except for number of companies and number of establishments). In the case of U.S. Economic Census, economic indicators are reported for years ending in "2" and "7." If an industry has a small number of companies, selected economic indicators (e.g., number of companies and/or number of establishments) may not be disclosed due to data confidentiality issues. The economic indicators are reported for the United States and for all individual states. The web links to data sources are provided in Appendix II.

The number of companies includes all companies operating in the industry.[2] ***The number of establishments*** includes all establishments associated with the industry. The number of establishments may or may not be identical with the number of companies, as it was explained in the previous section. ***The number of employees*** includes all full-time and part-time employees on the payrolls. ***The number of production workers*** includes workers engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping, maintenance, repair, recordkeeping, and other services closely associated with the production operations. ***The number of production workers hours*** includes all hours worked or paid for at the manufacturing plant.

Annual payroll includes the gross earnings of all employees on the payroll paid in the calendar year. ***Cost of materials*** refers to direct charges actually paid or payable for items consumed or put into production during the year; in particular, it includes the cost of materials or fuel consumed. In the case of food manufacturing industries, the cost of materials typically includes the cost of agricultural materials, semi-processed foodstuffs, other ingredients, packaging and containers, fuels and energy, and contract work. ***Capital expenditures*** represent the total new and used capital expenditures reported by establishments in operation; these are the expenditures related to new and used machinery and equipment as well as permanent additions and major alterations to manufacturing establishments.

Value of shipments (revenue or sales) includes the received or receivable net selling values, "Free on Board" (FOB) plant (exclusive of freight and taxes), of all products shipped as well as all miscellaneous receipts. ***Value added*** is the difference between value of shipments and cost of materials, supplies, containers, fuel, plastic, purchased electricity, and contract work. The value-added indicator avoids duplication resulting from the use of products of some establishments as materials by others. For example, in the case of food manufacturing industries, the cost of raw agricultural materials, containers, packaging, and fuel is included in the value of shipments; however, it is not included in the value added generated by these industries. In other words, the value added includes the value of recourses added to raw agricultural materials to produce the final product and also the value that consumers attribute to a particular product, which is reflected in the level of price and profit. Therefore, the value added in food manufacturing typically includes wages paid to employees, depreciation of fixed assets (i.e., capital expenditures), advertising and promotion expenditures, and profit.

While both the value of shipments and value added can be used to evaluate the size, structure, and performance of food manufacturing industries, the value added is considered to be superior to the value of shipments as it avoids double-counting of certain resources, which is inherent to the value of shipments. Therefore, the value added is a preferred measure to assess the performance of food manufacturing industries (Connor et al. 1985; Connor 1988). According to the U.S. Census Bureau, "value added is considered to be the best value measure available for comparing the relative economic importance of manufacturing among industries and geographic areas" (U.S. Census Bureau 2024c).

5 Data Analysis: Methodologies

To analyze the size, structure, and performance of food manufacturing industries in undergraduate research, a variety of economic indicators reported by the U.S. Census Bureau and economic ratios (shares) constructed using these indicators are used. Selected economic indicators and economic ratios (shares) are discussed in two books focusing on the structure, conduct, and performance of food manufacturing industries in the United States (Connor et al. 1985; Connor 1988), U.S. Department of Agriculture, Economic Research Service reports (Huang 2003; U.S. Department of Agriculture, Economic Research Service 2023), and several academic articles (Asiseh et al. 2009, 2010; Bolotova 2008, 2016;

[2] The economic indicator definitions are provided on the Glossary webpage of the U.S. Census Bureau (U.S. Census Bureau 2024c). These definitions are also summarized in PDF reports organizing U.S. Economic Census survey data (for example, see U.S. Economic Census 2004, Appendix A. Explanation of Terms).

Bolotova and Asiseh 2009; Capps, Fuller, and Nichols 1988; Christy and Connor 1989; Henderson and McNamara 1997, 2000; Rogers 2001; Salin, Atkins, and Salame 2002).

5.1 Analyzing the Size and Structure of Food Manufacturing Industries

The size of the food manufacturing industry group (at a three-digit classification level) and/or the size of individual food manufacturing industries (at a four-digit or higher classification level) can be analyzed by using economic indicators relevant to a particular research project objective. The economic indicators themselves (without any transformation) for the analyzed industry in a particular year generally can be used to characterize this industry's size. Typically, the industry revenue (value of shipments or sales) is used to evaluate the industry size. The cost of materials (raw agricultural commodities) purchased to produce food products can also be used to evaluate the industry size on the input side. Also, the number of employees employed by the industry may be used as an indicator of the industry size.

To analyze the structure of the food manufacturing industry group (at a three-digit classification level), the share of each individual food manufacturing industry (at a four-digit classification level) is calculated in the total value of selected economic indicator. For example, the following economic indicators can be used to analyze the industry structure: revenue (value of shipments or sales), value added, cost of materials, number of employees, etc. Figure 1 depicts the selected results generated by a student who analyzed the food manufacturing industry structure in Iowa.[3]

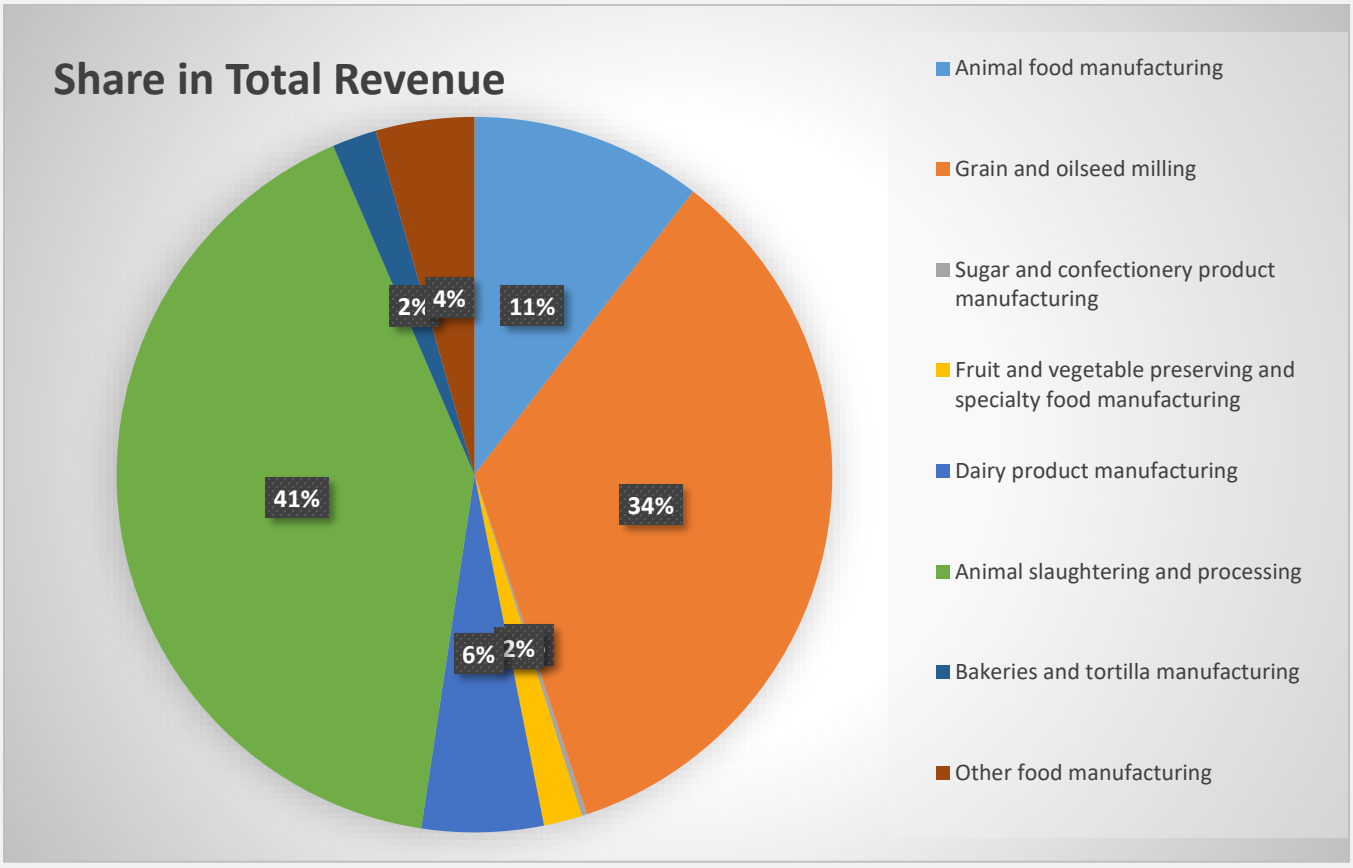

Figure 1: The Structure of the Food Manufacturing Industry in Iowa (by Value of Shipments), 2021

[3] Similar charts were developed by using the number of establishments and the number of employees.

Table 1: The Industry Revenue Structure and Profitability: Framework		
	Measure ($)	**Revenue structure**
[1]	**Revenue**	**100 percent**
[2]	**Costs = [2.1] + [2.2] + [2.3]**	**[Costs/Revenue]*100**
[2.1]	Costs of Materials	[Cost of Materials/Revenue]*100
[2.2]	Annual Payroll	[Annual Payroll/Revenue]*100
[2.3]	Capital Expenditures	[Capital Expenditures/Revenue]*100
[3]	**Profit = [1] – [2]**	**[Profit/Revenue]*100**

5.2 Analyzing the Performance of Food Manufacturing Industries

5.2.1 Revenue Structure and Profitability Analysis

The cost and revenue-related economic indicators can be used to analyze the revenue structure and profitability of food manufacturing industries. This analysis can focus on the food manufacturing industry group (at a three-digit classification level) and on individual food manufacturing industries (at a four-digit or higher classification level).

The economic indicators to be used in this analysis are: revenue (value of shipments) and cost-related indicators that include cost of materials, annual payroll, and capital expenditures. The profit proxy[4] is calculated as the difference between the revenue and total costs (all cost-related indicators combined). The profit proxy is calculated in $ and as a percentage of the revenue. To evaluate the revenue structure, the share of each cost-related indicator and profit proxy in the total industry revenue is calculated. Table 1 presents the methodology of revenue structure and profitability analysis. Tables A3.1–A3.2 and Figure A3.1 included in Appendix III summarize the selected results generated by a student who used this methodology to analyze the revenue structure and profitability of food manufacturing industries in the United States and Iowa.

5.2.2 Economic Effectiveness Analysis

The number, cost, and revenue-related economic indicators can be used to analyze economic effectiveness of food manufacturing industries. These economic indicators can be combined in different ways to construct ratios of economic effectiveness. This analysis can focus on the food manufacturing industry group (at a three-digit classification level) and on individual food manufacturing industries (at a four-digit or higher classification level).

For example, one approach is to combine cost-related indicators with revenue-related indicators to construct ratios reflecting how effectively different types of resources are used (materials, labor, and capital). This analysis would also provide evidence on productivity of food manufacturing industries. Another approach is to combine selected revenue and/or cost-related indicators with number-related indicators to evaluate economic effectiveness. The examples of the ratios would include the number of production workers per establishment, the number of employees per establishment, the value added per one production worker, the value added to cost of materials, the value of shipments per one production worker, and the value of shipments per one production worker hour. Table 2 summarizes selected ratios of economic effectiveness. Tables A4.1–A4.5 included in Appendix IV summarize the selected results generated by a student who used this methodology to analyze economic effectiveness of food manufacturing industries in Iowa, Illinois, and Missouri.

[4] The profit measure is referred to as "profit proxy" because there are other cost-related indicators that are not collected and are not used in this analysis. The share of these "other costs" is relatively small, compared to the three major cost components: annual payroll, cost of materials, and capital expenditures that are used in this analysis.

Table 2: Ratios of Economic Effectiveness

Ratios
Ratio characterizing the overall effectiveness of production and marketing processes
$\frac{Value\ added}{Value\ of\ shipments} * 100\%$
Ratios characterizing the effectiveness of production workers use
$\frac{Number\ of\ production\ workers}{Number\ of\ employees} * 100\%$
$\frac{Value\ Added}{Number\ of\ production\ workers\ hours}\ [\$\ per\ hour]$
Ratios characterizing the effectiveness of capital and material resources use
$\frac{Value\ added}{Capital\ expenditures}$
$\frac{Value\ added}{Cost\ of\ materials}$

6 Research Projects: Alternative Designs

There are several alternative research designs for undergraduate research projects focusing on the size, structure, and performance of food manufacturing industries.

1. Analyzing data for a particular year for an individual state.
2. Analyzing data for a particular year across a number of states located in the same geographic region. The analyzed states should have a similar agriculture and food manufacturing profile.
3. Analyzing data over time for an individual state or a group of states located in the same geographic region. In addition to analyzing changes in the size, structure, and performance of food manufacturing industries, this analysis would allow to identify economic development trends over time. The economic indicators expressed in $ should be adjusted using producer-price indices to make these indicators comparable over time (U.S. Bureau of Labor Statistics 2024).
4. Analyzing data for a particular year or overtime for an individual state and the United States. In the case of the performance analysis, the U.S. level indicators may be used as "average" performance indicators. An individual state performance can be compared to the U.S average performance (benchmarking analysis). Tables A3.1 and A3.2 included in Appendix III summarize selected results generated by a student who benchmarked the profitability of food manufacturing industries in Iowa relative to the average profitability characterizing food manufacturing industries in the United States.
5. Analyzing data for food manufacturing industries at different aggregation (NAICS digit-classification) levels and focusing on industries that are most relevant to the analyzed state.

7 Potential Audiences for Students' Research Outputs

The results of research projects evaluating the size, structure, and performance of food manufacturing industries could be used by Extension and outreach personnel, agribusiness decision-makers, financial institutions, and government agencies in several ways.

- The research projects can be tailored to contribute to Extension (outreach) programs directed toward food processing businesses. The research outputs can be used to develop information sheets for food processing businesses and local and state government authorities, as well as presentations to Extension and outreach communities.
- The research projects can be designed as business consulting projects for a particular food manufacturing business, or a cooperative involved in food manufacturing. The economic performance of an individual establishment or a group of establishments belonging to the same company can be compared to the average economic performance characterizing a particular industry in a particular state. Consequently, if needed, the company's production, input procurement, and/or marketing strategies may be modified to improve economic performance of the analyzed establishment(s) and the company.
- The research results may be used by agribusiness decision-makers when they make decisions on whether to expand the existing food manufacturing operations. The expansion may be within the same and/or a different state. The research results may also be useful for agribusiness decision-makers who consider getting involved in food manufacturing businesses.
- Financial institutions working in the region could utilize the results in their relations with agricultural and food businesses when decisions on financial assistance are made. For example, economic development trends characterizing a particular food manufacturing industry may affect decisions of the financial institutions on the amount of financial assistance to be provided for business entities operating in this industry.
- Government agencies may use the research results in their decision-making process; for example, when various agricultural and food promotion programs are developed, as well as when different types of grants are awarded to agricultural and food businesses.

8 Conclusions and Recommendations

This article provides an example of how to create and implement a research experience for undergraduate students. This research experience will improve career opportunities for undergraduate students and will provide information relevant for agribusiness and policy decision-makers. The research example presented in the article can be easily modified to fit the course, the level of undergraduate students, and the audiences.

- The research project focus can be readily refined to an appropriate scale and scope for undergraduate students. Research questions can be specified as not being too narrow nor too broad.
- The research area can be tailored to any geographic area of the United States, so location is not a constraint, making this example easily adapted and adopted by instructors at any U.S. college or university.
- The research utilizes publicly available government data, which are periodically updated, so undergraduate students do not have to collect primary data, and instructors, over time, could even recycle specific research questions with successive cohorts of students, given that new data might capture trends or shifts in industry dynamics.

The research projects developed using the example presented in this article can be incorporated in stand-alone undergraduate research courses, in capstone courses in undergraduate agribusiness programs, and in upper-level undergraduate courses taught in agribusiness and agricultural economics programs where research projects are a requirement.

A limitation is that students might need help of the instructor to locate and download data to be used in their research. The data search process might be confusing for some students. Appendix II explains the steps to follow to locate and download data on the U.S Census Bureau webpages (U.S. Economic Census surveys and Annual Surveys of Manufactures). In addition, the web links are provided to the PDF reports that conveniently visualize data and provide all definitions (U.S. Economic Census 2002).[5] Beginning in 2007, the U.S. Census Bureau discontinued publishing U.S. Economic Census data organized in PDF reports. However, these reports for earlier years may serve as a useful guide for understanding data and how these data are now organized in the U.S. Economic Census online database (U.S. Census Bureau 2024d). The teaching note Excel file includes yearly data for the U.S. food manufacturing industries reported in Annual Surveys of Manufactures for the period of 2018 to 2021 that can be used in undergraduate research projects.

About the Author: Yuliya V. Bolotova is an Assistant Teaching Professor at Iowa State University (Corresponding author email: yuliya@iastate.edu). Luke Juffer is an Undergraduate Student at Iowa State University. Haylie Moore is an Undergraduate Student at Iowa State University. The names of undergraduate students are listed in alphabetical order.

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[5] The weblink is provided in the Reference section. The PDF reports for all food manufacturing industries surveyed in 2002 are available on this webpage.

Appendix I: Research Project Description

Spring 2023
Iowa State University HON 290H Section B3 "Undergraduate Honors Students Research"
Structure and Performance of Food Manufacturing Industries in Iowa

Iowa is the second largest agricultural production state in the country following California. A large volume of agricultural production in Iowa creates significant economic opportunities for food manufacturing industries located in Iowa and the Midwest region. The firms operating in food manufacturing industries purchase agricultural products from agricultural producers to process them into food products and animal feed products. Food manufacturing industries are important drivers of rural and economic development of the state and the region.

The objective of this research project is to analyze the structure and performance of food manufacturing industries in Iowa and in the Midwest. The main source of data is the U.S. Census Bureau: U.S. Economic Census Surveys and Annual Surveys of Manufactures. The U.S. Economic Census classifies food manufacturing industries into the following groups: animal food manufacturing; grain and oilseed milling; sugar and confectionary product manufacturing; fruit and vegetable preserving and specialty food manufacturing; dairy product manufacturing; meat product manufacturing; seafood product preparation and packaging; bakeries and tortilla manufacturing; and other food manufacturing.

The main economic indicators to be used in the analysis include the number of establishments, annual payroll, the number of production workers, costs of materials, capital expenditures, the value of shipments, and the value added. These economic indicators are reported for individual food manufacturing industries.

Our analysis will proceed in two directions. First, we will analyze the structure of food manufacturing industries by calculating each individual industry's share in the total value of the economic indicators associated with all food manufacturing industries as a group. Second, we will calculate and evaluate changes in the economic indicators over time. The changes in the economic indicators are to be analyzed for individual food manufacturing industries over the last two decades to determine their economic performance and economic development trends. In addition, using the same economic indicators, the performance of food manufacturing industries in Iowa will be compared to the performance of food manufacturing industries in other Midwestern states (Wisconsin, Minnesota, Missouri, and Illinois). The data analysis will be conducted in Excel.

To get a general idea about this type of research, students are encouraged to check the following articles:

Bolotova, Y. 2016. "Food Manufacturing Industry in South Carolina: An Analysis of the Size, Structure, and Performance." *Journal of Food Distribution Research* https://ageconsearch.umn.edu/record/232289?ln=en

Bolotova, Y., and F. Asiseh. 2009. "Evaluating Economic Performance of Food Manufacturing Industries: An Analysis of the U.S. Pacific Northwest States." *Journal of Food Distribution Research*. https://ageconsearch.umn.edu/record/99769?ln=en

Bolotova, Y. 2008. "The Economic Performance of Food-Manufacturing Industries in Idaho." *Journal of Food Distribution Research*. https://ageconsearch.umn.edu/record/55586?ln=en

Skills

1. Data analysis using Excel (organizing data; calculating changes in physical units and percentage changes; calculating shares; developing graphs).
2. Excellent writing skills.
3. Willingness to learn how to download data using the U.S. Economic Census database (the guidance will be provided).
4. Willingness to conduct a literature review relevant to the structure and performance of food manufacturing industries (the guidance will be provided).

Responsibilities

1. To compile a data set by downloading data from the U.S. Economic Census database.
2. To conduct data analysis using Excel (organizing data; calculating changes in physical units and percentage changes; calculating shares; developing graphs).
3. To write a report summarizing the results of data analysis and relevant literature reviews.

Appendix II: U.S. Census Bureau Data Sources

I. U.S. Economic Census (five-year surveys of industries)

1. Data webpage
https://www.census.gov/programs-surveys/economic-census.html
2. Data tables
https://www.census.gov/programs-surveys/economic-census/data/tables.html
3. Tables for Manufacturing Industries (we will need a four-digit industry classification level and FOOD manufacturing industries only)
https://www.census.gov/data/tables/2017/econ/economic-census/naics-sector-31-33.html
The insert from the webpage is below.
Manufacturing (NAICS Sector 31-33) 2017
Below are the data released in the 2017 Economic Census for Manufacturing. All data are available as formatted tables on data.census.gov and downloadable csv files on the census FTP site.
Geographic Area Statistics
As part of the ECNBASIC data set, Geographic Area Statistics provide summary statistics by geographic area for establishments and firms with paid employees. Data are shown on the 2017 North American Industry Classification System (NAICS) basis. State data will be released on a flow basis starting in January 2020; see the 2017 Release Schedules for more information.
Formatted Tables (links to data.census.gov)

- EC1700BASIC – All Sectors: Summary Statistics for the U.S., States, and Selected Geographies: 2017
- EC1731BASIC – Manufacturing: Summary Statistics for the U.S., States, and Selected Geographies: 2017

To see data for a specific state for this sector, use the drop-down below. Additional geographies can be selected under the geography menu within the table on data.census.gov.
Dataset(s) (links to FTP) ZIP FILES

- **EC1731BASIC** – Manufacturing: Summary Statistics for the U.S., States, and Selected Geographies: 2017

4. PDF Reports for 2002: Industry-Specific
https://www.census.gov/library/publications/2002/econ/census/manufacturing-reports.html

- PDF reports provide tables for 2002. Data for the following years are available only in the online database (U.S. Census Bureau 2024b).
- PDF reports provide detailed definitions of all economic indicators.
- U.S. reports and state-specific reports.

II. Annual Survey of Manufactures
1. Data webpage
https://www.census.gov/programs-surveys/asm.html
2. Tables
https://www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html

Appendix III: The Revenue Structure and Profitability Analysis

Table A3.1: The Revenue Structure and Profitability of Food Manufacturing Industries in the United States, 2021

[NAICS code] Industry	Value of shipments	Annual payroll	Cost of materials	Capital expenditures	Total costs	Profit proxy
	$1,000,000					
[311] Food Manufacturing	***904,147.676 (100.0)***	***79,699.884 (8.8)****	***552,686.256 (61.1)***	***19,788.535 (2.2)***	***652,174.675 (72.1)***	***251,973.001 (27.9)***
[3111] Animal Food Manufacturing	65,897.742 (100.0)	3,543.899 (5.4)	41,248.482 (62.6)	960.945 (1.5)	45,753.326 (69.4)	20,144.416 (30.6)
[3112] Grain and Oilseed Milling	105,594.612 (100.0)	3,769.484 (3.6)	80,611.609 (76.3)	2,122.904 (2.0)	86,503.997 (81.9)	19,090.615 (18.1)
[3113] Sugar and Confectionery Product Manufacturing	40,174.294 (100.0)	4,339.513 (10.8)	22,608.194 (56.3)	1,201.228 (3.0)	28,148.935 (70.1)	12,025.359 (29.9)
[3114] Fruit and Vegetable Preserving and Specialty Food Manufacturing	77,745.532 (100.0)	8,550.269 (11.0)	42,110.786 (54.2)	1,972.569 (2.5)	52,633.624 (67.7)	25,111.908 (32.3)
[3115] Dairy Product Manufacturing	130,296.821 (100.0)	9,357.991 (7.2)	87,876.43 (67.4)	2,713.725 (2.1)	99,948.146 (76.7)	30,348.675 (23.3)
[3116] Animal Slaughtering and Processing	266,996.588 (100.0)	25,027.474 (9.4)	175,320.793 (65.7)	5,062.469 (1.9)	205,410.736 (76.9)	61,585.852 (23.1)
[3118] Bakeries and Tortilla Manufacturing	76,512.821 (100.0)	12,025.957 (15.7)	31,183.238 (40.8)	2,280.83 (3.0)	45,490.025 (59.5)	31,022.796 (40.5)
[3119] Other Food Manufacturing	126,586.386 (100.0)	11,545.469 (9.1)	62,595.814 (49.4)	3,125.939 (2.5)	77,267.222 (61.0)	49,319.164 (39.0)

Source: U.S. Census Bureau (2021)
*The shares of each cost indicator and profit proxy in the value of shipments are in parentheses.

Table A3.2: The Revenue Structure and Profitability of Food Manufacturing Industries in Iowa, with Comparison to the United States, 2021

[NAICS code] Industry	Value of shipments	Annual payroll	Cost of materials	Capital expenditures	Total costs	Profit proxy	Profitability: Iowa compared to the U.S.
				$1,000,000			
[311] Food Manufacturing	***45,375.98 (100.0)***	***3,041.778 (6.7)****	***31,800.829 (70.1)***	***962.985 (2.1)***	***35,805.592 (78.9)***	***9,570.392 (21.1)***	***Below Average***
[3111] Animal Food Manufacturing	4,750.27 (100.0)	265.615 (5.6)	2,897.532 (61.0)	87.843 (1.9)	3,250.99 (68.4)	1,499.275 (31.6)	Above Average
[3112] Grain and Oilseed Milling	15,628.72 (100.0)	472.47 (3.0)	12,463.428 (79.8)	224.637 (1.4)	13,160.535 (84.2)	2,468.183 (15.8)	Below Average
[3113] Sugar and Confectionery Product Manufacturing	106.463 (100.0)	15.969 (15.0)	56.772 (53.3)	0.198 (0.2)	72.939 (68.5)	33.524 (31.5)	Above Average
[3114] Fruit and Vegetable Preserving and Specialty Food Manufacturing	787.992 (100.0)	100.86 (12.8)	626.226 (79.5)	58.402 (7.4)	785.488 (99.7)	2.504 (0.3)	Below Average
[3115] Dairy Product Manufacturing	2,493.46 (100.0)	280.003 (11.2)	1,420.506 (57.0)	22.426 (0.9)	1,722.935 (69.1)	770.523 (30.9)	Above Average
[3116] Animal Slaughtering and Processing	18,676.82 (100.0)	1,648.407 (8.8)	12,806.11 (68.6)	358.068 (1.9)	14,812.585 (79.3)	3,864.236 (20.7)	Below Average
[3118] Bakeries and Tortilla Manufacturing	909.793 (100.0)	88.15 (9.7)	356.938 (39.2)	9.436 (1.0)	454.524 (50.0)	455.269 (50.0)	Above Average
[3119] Other Food Manufacturing	2,022.47 (100.0)	170.303 (8.4)	1,173.317 (58.0)	201.976 (10.0)	1,545.596 (76.4)	476.878 (23.6)	Below Average

Source: U.S. Census Bureau (2021)
*The shares of each cost indicator and profit proxy in the value of shipments are in parentheses.
"Above-average performance" is if Iowa's profit proxy is greater than the U.S. profit proxy (Table A3.1).
"Below-average performance" is if Iowa's profit proxy is smaller than the U.S. profit proxy (Table A3.1).

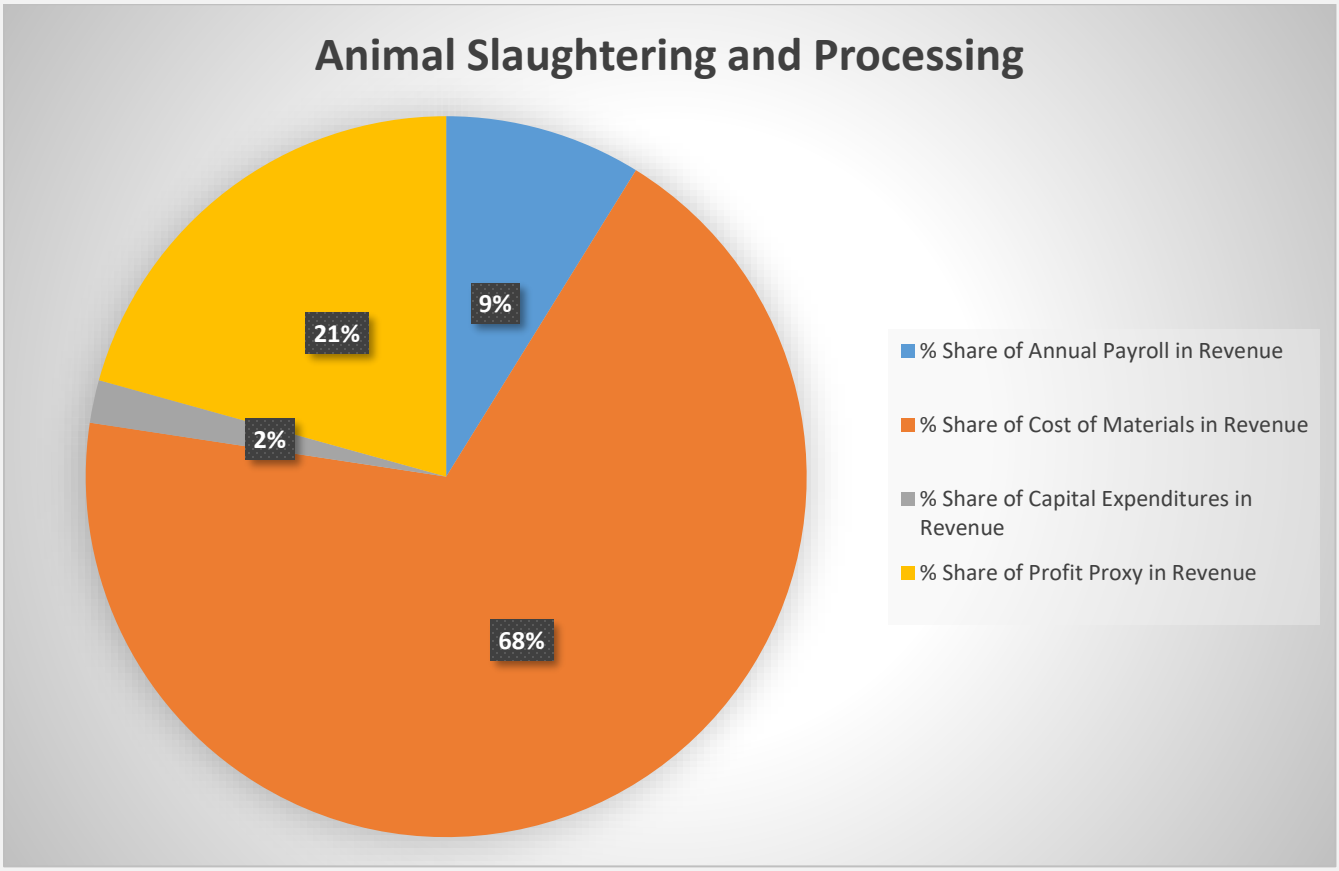

Figure A3.1: The Revenue Structure of Animal Slaughtering and Processing Industry in Iowa, 2021

Source: U.S. Census Bureau (2021)

Appendix IV: Economic Effectiveness Analysis

Table A.4.1: Share of the Value Added in the Value of Shipments, 2021

NAICS code	Industry	Iowa	Illinois	Missouri
311	***Food Manufacturing***	***30.2[l]***	***36.6[h]***	***34.5***
3111	Animal food manufacturing	39.4[l]	40.9	54.8[h]
3112	Grain and oilseed milling	20.7	20.9[h]	20.5[l]
3113	Sugar and confectionery product manufacturing	N/A	43.4	N/A
3114	Fruit and vegetable preserving and specialty food manufacturing	N/A	40.9[l]	42.8[h]
3115	Dairy product manufacturing	43[h]	33[l]	N/A
3116	Animal slaughtering and processing	31.6[l]	37.4[h]	34.2
3118	Bakeries and tortilla manufacturing	60.2[h]	50.7	44.9[l]
3119	Other food manufacturing	41.9[l]	52.5	53.7[h]

Source: U.S. Census Bureau (2021)
[h] Highest share among the three states. [l] Lowest share among the three states.
N/A means that either the industry is not present in the state, or data are not reported due to confidentiality reasons.

Table A4.2: Ratio of the Value Added to the Cost of Materials, 2021

NAICS code	Industry	Iowa	Illinois	Missouri
311	***Food Manufacturing***	***0.4[l]***	***0.6[h]***	***0.5***
3111	Animal food manufacturing	0.6[l]	0.7	1.2[h]
3112	Grain and oilseed milling	0.3	0.3	0.3
3113	Sugar and confectionery product manufacturing	N/A	0.8	N/A
3114	Fruit and vegetable preserving and specialty food manufacturing	N/A	0.7	0.7
3115	Dairy product manufacturing	0.8[h]	0.5[l]	N/A
3116	Animal slaughtering and processing	0.5[l]	0.6[h]	0.5[l]
3118	Bakeries and tortilla manufacturing	1.5[h]	1	0.8[l]
3119	Other food manufacturing	0.7[l]	1.1[h]	1.1[h]

Source: U.S. Census Bureau (2021)
[h] Highest ratio among the three states. [l] Lowest ratio among the three states.
N/A means that either the industry is not present in the state, or data are not reported due to confidentiality reasons.

Table A4.3: Ratio of Value Added to the Number of Production Worker Hours, 2021

NAICS code	Industry	Iowa	Illinois	Missouri
311	***Food Manufacturing***	***152***	***151.1[l]***	***152.4[h]***
3111	Animal food manufacturing	333.7	241.8[l]	441[h]
3112	Grain and oilseed milling	367.2[h]	359.6	268[l]
3113	Sugar and confectionery product manufacturing	N/A	149.9	N/A
3114	Fruit and vegetable preserving and specialty food manufacturing	N/A	86.2[l]	239.6[h]
3115	Dairy product manufacturing	169[h]	163.9[l]	N/A
3116	Animal slaughtering and processing	100.7	131.1[h]	87[l]
3118	Bakeries and tortilla manufacturing	191.8[h]	93.8[l]	190.9
3119	Other food manufacturing	166.7[l]	204.6	294.9[h]

Source: U.S. Census Bureau (2021)
[h] Highest ratio among the three states. [l] Lowest ratio among the three states.
N/A means that either the industry is not present in the state, or data are not reported due to confidentiality reasons.

Table A4.4: Share of Number of Production Workers in Number of Employees, 2021

NAICS code	Industry	Iowa	Illinois	Missouri
311	***Food Manufacturing***	***82.4***	***78.1[l]***	***83.9[h]***
3111	Animal food manufacturing	76.8	70.6[l]	79.8[h]
3112	Grain and oilseed milling	76.4	73[l]	81.4[h]
3113	Sugar and confectionery product manufacturing	63.2[l]	79.2[h]	72.6
3114	Fruit and vegetable preserving and specialty food manufacturing	87.3[h]	74.7[l]	83.5
3115	Dairy product manufacturing	60.6[l]	81	86.7[h]
3116	Animal slaughtering and processing	87.1[h]	83.4[l]	86.1
3118	Bakeries and tortilla manufacturing	84.3[h]	78.3[l]	79.4
3119	Other food manufacturing	78.2[h]	71.5[l]	77.0

Source: U.S. Census Bureau (2021)
[h] Highest share among the three states. [l] Lowest share among the three states.
N/A means that either the industry is not present in the state, or data are not reported due to confidentiality reasons.

Table A4.5: Ratio of the Value Added to Capital Expenditures, 2021

NAICS code	Industry	Iowa	Illinois	Missouri
311	***Food Manufacturing***	***14.2[l]***	***15.3***	***16.7[h]***
3111	Animal food manufacturing	21.3[l]	28.6	48.6[h]
3112	Grain and oilseed milling	14.4[h]	11.5[l]	14
3113	Sugar and confectionery product manufacturing	N/A	20.1	N/A
3114	Fruit and vegetable preserving and specialty food manufacturing	N/A	17.3[l]	41.3[h]
3115	Dairy product manufacturing	47.8[h]	12.3[l]	N/A
3116	Animal slaughtering and processing	16.5	20.9[h]	8.8[l]
3118	Bakeries and tortilla manufacturing	58[h]	11.8[l]	35.3
3119	Other food manufacturing	4.2[l]	14.9	29.8[h]

Source: U.S. Census Bureau (2021)

[h] Highest ratio among the three states. [l] Lowest ratio among the three states.

N/A means that either the industry is not present in the state, or data are not reported due to confidentiality reasons.

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